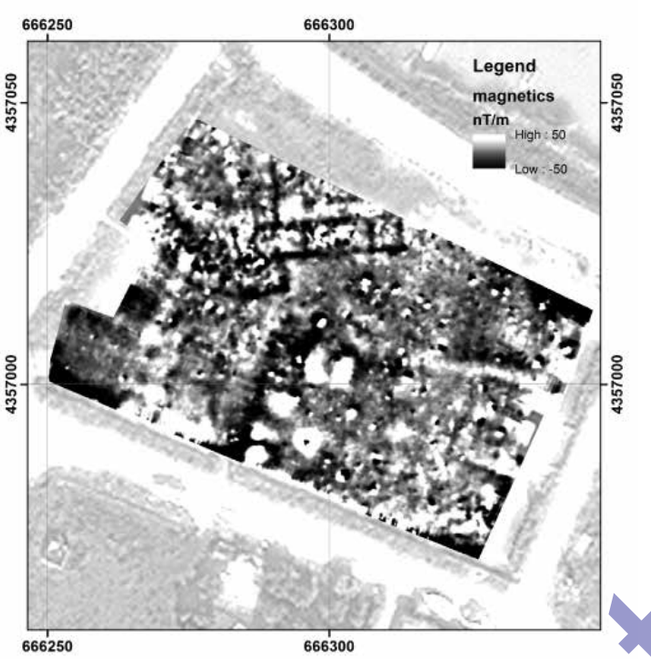

Fig. 3. Results of the SENSYS magnetic prospection from the field close to the shoreline

is subdivided into four rooms. The western room appears to have an apsidal end. North of these rooms, a large square area (courtyard?) appears in the geophysical data. The plan of the particular monument is suggestive either of a small theater with an attached portico or of a covered odeion, although a bath complex cannot be ruled out.

Overall, geophysical survey in Demetrias was more than revealing. It confirmed sections of the older German plan, identified various new features, blocks and roads, provided accurate details of the internal structural planning of the city blocks, and indicated the expansion of the city plan in areas that were completely unexplored. The resulting maps have contributed significantly to an understanding of the usage of the urban space in the Hellenistic and Roman periods, allowing comparisons with other similar cities in the Greek mainland.

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Cultural variations of the Neolithic landscape of Thessaly

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KEY-WORDS: geophysical survey, multisensor magnetic survey, EM, GPR, RM, satellite remote sensing, UAV, magnetic susceptibility

INTRODUCTION

The Neolithic period in Europe (6800–2000 BC) is widely considered a key epoch in the evolving relationship of human beings and their inhabitable environment. Groups of hunters and gatherers gave way to more sedentary agrarian societies involved with animal husbandry and the cultivation of subsistence crops. Various interdisciplinary studies have focused on

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Fig. 1. Results of the SENSYS MX magnetic gradiometer survey at the Almyros 2 Neolithic tell

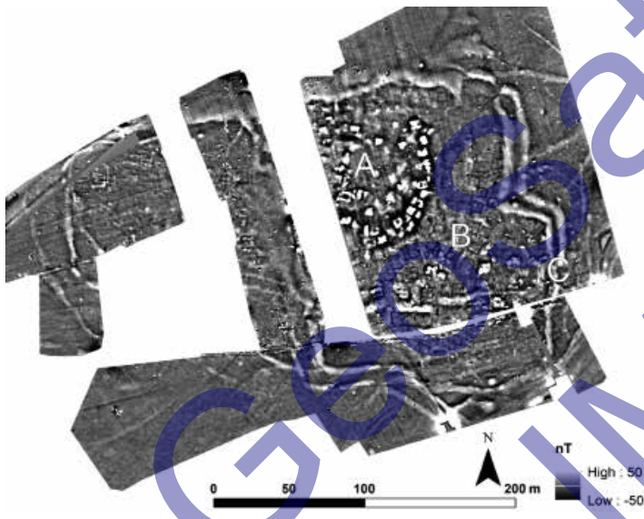

Fig. 2. *Magoula* Almyriotiki. Results of the magnetic survey showing details of the intra-site organization of the settlement: main core of the *magoula* (A) and peripheral structures (B). Traces of flooding episodes are indicated to the north of the *magoula*, where the outer double ditch signature (C) seems to fade away.

settlement patterns of the Neolithic period and Greece and Thessaly have been particularly challenging in this respect, being considered one of the first regions in Europe where these new groups developed. Indeed, Thessalian geography and geology make it a closed geographical unit with well-defined natural boundaries and sub divisions. It is therefore a promising region for reconstructing the major habitation models of Neolithic farming groups in Greece and examining the relation over time of the anthropic and natural landscapes.

METHODOLOGICAL APPROACHES

For the past three years the ARISTEIA-IGEAN (Innovative Geophysical Approaches for the Study of Early Agricultural Villages of Neolithic Thessaly) project has been conducting a regular and extensive geophysical investigation of the Neolithic landscape of Thessaly. It has explored specifically a number of Neolithic tells (*magoules*) in coastal Thessaly, designing and implementing for the purpose a geophysical strategy for a rapid, high-resolution assessment of their subsurface. Geophysical surveys made use of multi-component geophysical instruments (single- and multi-sensor magnetic, single- and multi-antenna GPR arrays, multifrequency EM, soil resistance and chemical and magnetic analyses) for broad coverage of the settlements. A SENSYS MX compact system with 8 FGM600 fluxgate gradiometer, GEM2 and CMD Mini Explorer conductivity meters were used for wide coverage. The magnetic survey offered high resolution data from all the regions. The EM units offered measurements of soil conductivity and magnetic susceptibility at various depths. In areas covered by trees or in the vicinity of modern structures, the surveys were adapted accordingly, using single-sensor magnetometers (Bartington G601), GPR (Noggin Plus with 250MHz antennas and MALA MIRA 8 channel GPR with 400MHz antennas) or resistivity (RM85 Twin probe array) meters. In most cases, however, more than three methods were applied, offering good verification of the suggested targets or complementarity of the different datasets. Sampling was denser for the GPR measurements (0.5 x 0.025 m) compared to the rest of the techniques (0.0125–1 m for G601 and 1 x 1 m for EM85). GPR use was particularly successful in calculating the depth of the cultural layers and estimating the vertical extent of architectural relics. Magnetic susceptibility and phosphate analyses were also applied to provide an index of space limits and usage types.

At the same time, UAV-IR aerial reconnaissance, historical airborne photos and satellite images were used to map both the surface of the sites and their environs, and expose any subtle features related to the environmental setting of the settlements. The satellite data came from WorldView-2, Geoeye-1, and Quickbird-1, and the aerial images went back to 1960. The photo-interpretation of the images relied heavily on the calculation of various vegetation indices and image combinations.

RESULTS

The results of the manifold remote-sensing approaches were extremely illuminating both in terms of identifying numerous details of the settlements and recognizing features that can be related to various past environmental episodes. On most of the surveyed tells, a dense cluster of daub structures was found at the core of the mound, demonstrating signs of burning. On some of the tells, as in the case of Almyros 2 (Floras and Sgouras 2004: 13–14; Wijnen and

Fig. 3. *Magoula* Rizomilos 2. Results of the magnetic survey superimposed on a GeoEye-1 satellite image taken on May 4, 2010. The satellite image is a pansharpened Intensity-Hue-Saturation combination. A second smaller similar tell is suggested to the east of the settlement. To the north, the magnetic signature and the satellite data indicate traces of past flooding activity. According to the locals, the region used to be flooded regularly in historical periods.

Rondiri 2004: 24–38), diverse usage was demonstrated on the mound, which was roughly 50 m in diameter. The clustered dwellings were clearly separated by an open/empty zone. In some cases, the nucleus of the tells was surrounded by small enclosures and the limits of the settlements were defined by a larger system of outer multiple ditches, usually of circular shape, all of which bear evidence of multiple entrances. At Almyros 2, an unoccupied area was identified between the nucleus of the tell and the outer ditches to the north, contrasting with the southern part, which seems to have been densely occupied (Fig. 1).

At the Almyriotiki *magoula* (Wijnen and Rondiri 2004: 37), a large settlement consisting of two-to-three room structures built of stone (especially evident in the magnetics and GPR data) extends around the main tell, covering an area of 200 m by 350 m (Fig. 2). The extensive settlement around the tell is surrounded by a double-ditch system with a 10 m gap between the ditches. A similar flat settlement of rectangular shape (~100 x 200 m) seems to have extended also around the nucleus of the Perdika 1 *magoula* (Floras and Sgouras 2004: 16). Mudbrick and stone-built dwellings seem to have coexisted outside the center of the tell, suggesting a diachronic occupation of the settlement. Located on a natural hilltop about 1 km away from Perdika 1, the

Perdika 2 *magoula*, which extends 100 m to 120 m, shows no significant signs of habitation. The few structures that were recognized here seem to be in isolation with respect to the rest of the site, which is partitioned off by a number of internal and external walls.

With respect to the environmental features suggested by the various approaches, the most striking were traces of palaeochannels or of past flooding activities in a number of settlements (i.e. Almyriotiki, Almyros 2, Perdika 1 and Rizomilos 2 (Fig. 3), which was indicated by both the soil signature and the disruptions of the outer ditches. The outer ditches may have also plausibly functioned as a water defensive/management system.

FINAL REMARKS

The multiyear survey of the Neolithic landscape of Thessaly demonstrated the successful application of geophysical, aerial and satellite remote-sensing techniques in the uncovering of the details and dynamics of the Neolithic settlements. The combination of an arsenal of diverse remote-sensing approaches was crucial to this task. It was possible to conceptualize similar and divergent characteristics of the settlements with regard to the planning and building materials, estimate the extent of the settlements and houses, study the intra-site organization of the structures, make a clear discrimination between built and unbuilt areas, understand the way of demarcation of the settlements through the existence of fortifications and ditches, and document the diachronic development of habitation.

The systematic scanning of about 16 *magoules* has made apparent differences in habitation and land use that makes the Neolithic landscape one of variation. Gaining for the first time a thorough understanding of settlement patterns in a small part of the Thessalian plain, it would still be illusive to conclude that we can draw conclusions for the area as a whole. A new frontier of knowledge has been opened evidently, including implications regarding the sustainability of the population, persistency of occupation, spatial and social stratification and exploitation of natural resources.

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